Roger Williams Park BMP Monitoring Report

Providence, RI

Produced by the Southeast New England Program (SNEP) Network

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Prepared by SNEP Network partner:

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Acknowledgements:

Roger Williams Park BMP Monitoring

In 2020 the University of New Hampshire Stormwater Center, the University of Rhode Island, the Providence Stormwater Innovation Center, and the City of Providence Parks Department formed a collaboration to do real time water monitoring in Roger Williams Park (RWP). Roger Williams park is a large and beloved public park that features an extensive pond system. However the water quality of the ponds is impaired, and they suffer from frequent cyanobacteria blooms. In recent years the City of Providence has put significant resources into installing stormwater best management practices (BMPs) in the park in order to reduce pollutant loading and improve water quality. The monitoring effort, which was led by UNH and continued in 2021 intended to: 1) provide high resolution data on the quality of water entering and leaving the pond system to guide future management 2) evaluate the performance of some of the established BMPs and compare them to design specifications.

The BMPs at Roger Williams Park were designed by Wood Environmental & Infrastructure Solutions, Incorporated. As part of their design Wood calculated the pounds of phosphorus each BMP would remove based on its size and type using a model. As part of our initial investigation of the BMPs we recalculated the phosphorus removal of each BMP using a newer EPA model.

Roger Williams Park BMP Phosphorus Reduction	
EPA Performance Curve Method	Sum of all BMPs
Watershed (ac)	35
Calculated WQV (cf)	119,732
P reduction (lb/yr)	62
N reduction (lb/yr)	490
TSS reduction (lb/yr)	15,242
Volume Reduction (cf/year)	5,031,039
From Wood Environmental	Sum of all BMPs
P reduction s (lb/yr)	31

Summary table showing of the phosphorus removal of BMPs calculated by Wood Environmental as well as calculated using the EPA Performance Curve Method

BMP Monitoring: Installation

Four BMPs (1B, 1C, 1E, and 30A) were monitored over the course of the summer in 2020. Six BMPs (15, 19C, 37C, 30B, 34, and 28) were monitored in 2021. To measure water infiltration, each BMP was outfitted with Onset HOBO water level data loggers which measure depth of water above the sensor. Data loggers were placed in the forebays, infiltration basins, and (where possible) the monitoring wells of BMPs. We surveyed the relative elevations of the positions of each logger in each BMP as well as the top of the weir walls, emergency overflows, inlets, and other major features. An additional data logger was put in a sheltered open-air location in the park to measure air pressure for correcting logger measurements for barometric pressure.

We installed two rain gauges in the park to collect local rain data, one on a utility pole, and a second near the Seal House. Remaining data gaps in the park rain gauges were filled using data from T. F. Green Airport.

BMP Monitoring: Preliminary Results

For each BMP, the logger data was corrected for barometric pressure, and then also adjusted to match relative elevation and screened to check for any water levels that overtopped the level of the emergency overflow. We also used the area of the bottom elevation of each part of each BMP (forebays and filter) to calculate the approximate volume of water infiltrated for each storm.
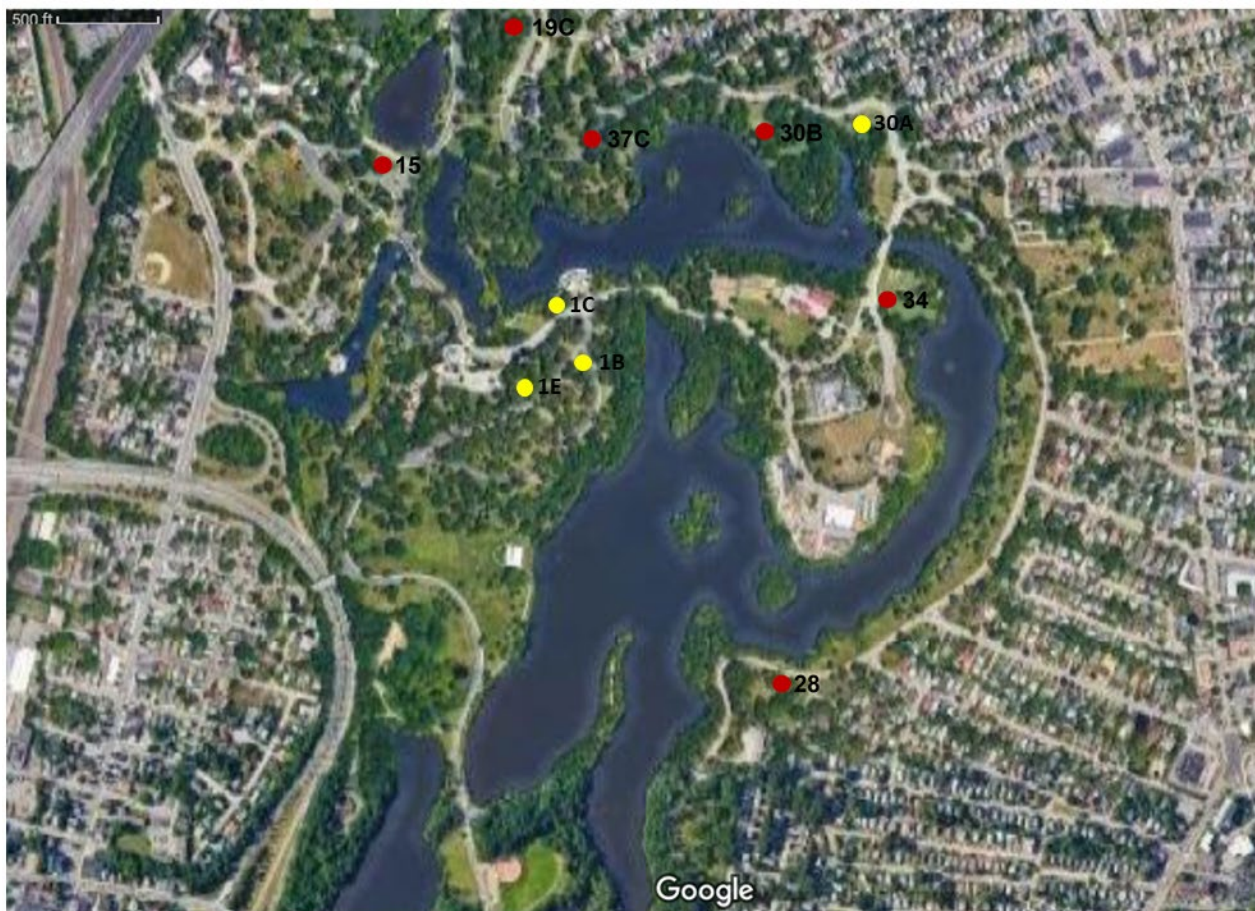
Aerial view of Roger Williams Park with locations of monitored BMPs marked (yellow for 2020, red for 2021).

30A

Photo of BMP 30A from Providence Stormwater Innovation Center

This BMP infiltrated and treated an estimated 118,000 gallons of water over the 6 months monitored. We had some gaps in the data from logger malfunction and from losing one logger to a lawnmower, so the amount infiltrated was likely more.

Event Date	Precipitation (in)	Volume in (ft³)	Volume bypass (ft³)	Infiltration (ft³)	Infiltration (gal)
4/30/2020	0.46	263	0	263	1,968
4/30/2020	2.32	476	0	476	3,559
5/1/2020	-	0	0	0	0
5/6/2020	0.12	219	0	219	1,640
5/8/2020	0.51	974	0	974	7,283
5/15/2020	0.11	0	0	0	0
5/15/2020	0.28	529	0	529	3,954
6/5/2020	0.14	0	0	0	0
6/6/2020	0.77	1,904	0	1,904	14,245
6/11/2020	2.33	1,053	0	1,053	7,873
6/24/2020	0.21	0	0	0	0
6/26/2020	2.19	0	0	0	0
6/27/2020	0.47	268	0	268	2,003
6/28/2020	-	129	0	129	964
6/30/2020	-	285	0	285	2,133
7/8/2020	0.72	0	0	0	0
7/14/2020	0.576	223	0	223	1,669
7/17/2020	0.168	196	0	196	1,468
7/28/2020	0.708	1,094	0	1,094	8,183
8/4/2020	0.168	0	0	0	0
8/16/2020	0.31		0	0	0
8/18/2020	0.11		0	0	0
8/22/2020	0.38	677	0	677	5,066
8/29/2020	0.19	29	0	29	213
9/2/2020	0.46	1,029	0	1,029	7,698
9/30/2020	0.64	1,146	0	1,146	8,570
10/5/2020	0.24	13	0	13	95
10/7/2020	0.11	13	0	13	101
10/8/2020	-	12	0	12	87
10/9/2020	-	12	0	12	93
10/10/2020	-	12	0	12	90
10/11/2020	-	14	0	14	102
10/13/2020	0.92	643	0	643	4,813
10/13/2020		811	0	811	6,065
10/16/2020	1.91	2,595	0	2,595	19,410
10/16/2020		135	0	135	1,013
10/20/2020	0.37	1,082	0	1,082	8,090
TOTAL				**15,834**	**118,447**

Table 1: Estimated volume infiltrated by BMP 30A for each storm monitored.
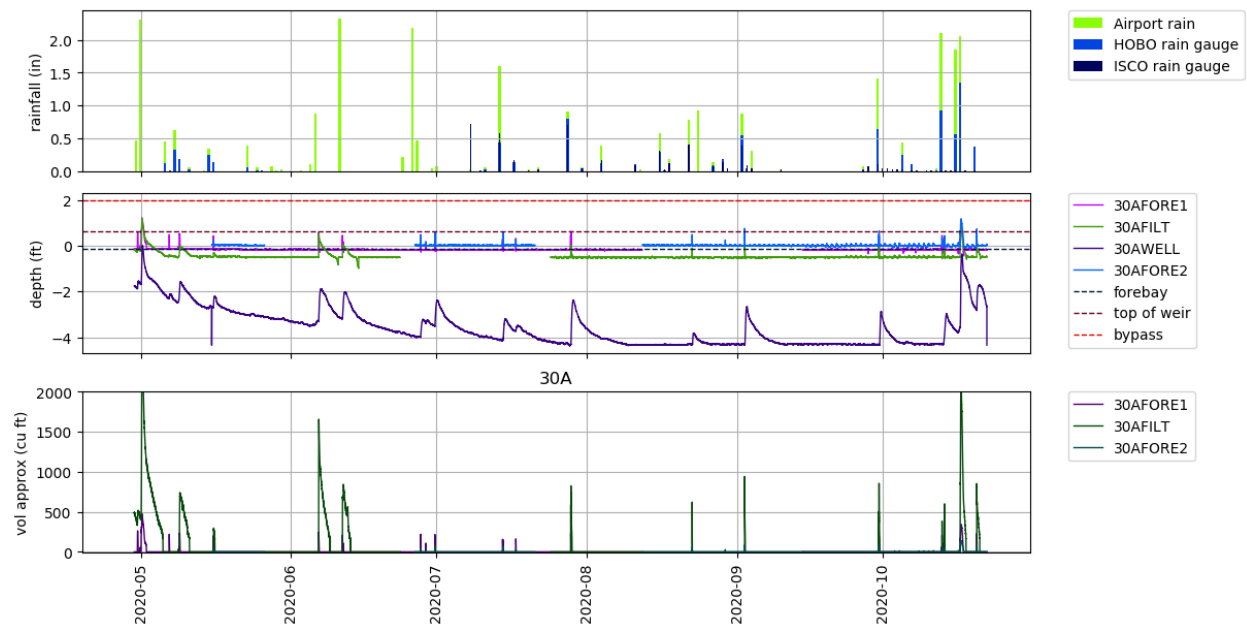
Figure 1: Water level in BMP 30A over time, with rainfall plotted above, and estimated water volume plotted below.

1C

Photo of BMP 1C from Providence Stormwater Innovation Center

This BMP did not appear to have received any stormwater during the four months it was monitored. It is also very visible and in a popular and high traffic area of the park, so when one of the data loggers disappeared in August we removed the remaining loggers.

Storm Date	Precipitation (in)	Volume in (ft³)	Volume bypassed (ft³)	Infiltration (ft³)
4/30/2020	0.46	0	0	0
4/30/2020	2.32	0	0	0
5/6/2020	0.12	0	0	0
5/8/2020	0.51	0	0	0
5/15/2020	0.11	0	0	0
5/15/2020	0.28	0	0	0
6/5/2020	0.14	0	0	0
6/6/2020	0.77	0	0	0
6/11/2020	2.33	0	0	0
6/24/2020	0.21	0	0	0
6/26/2020	2.19	0	0	0
6/27/2020	0.47	0	0	0
7/8/2020	0.72	0	0	0
7/14/2020	0.576	0	0	0
7/17/2020	0.168	0	0	0
7/28/2020	0.708	0	0	0
8/4/2020	0.168	0	0	0
8/16/2020	0.31	0	0	0
8/18/2020	0.11	0	0	0
8/22/2020	0.38	0	0	0
8/29/2020	0.19	0	0	0
TOTAL			**0**	**0**

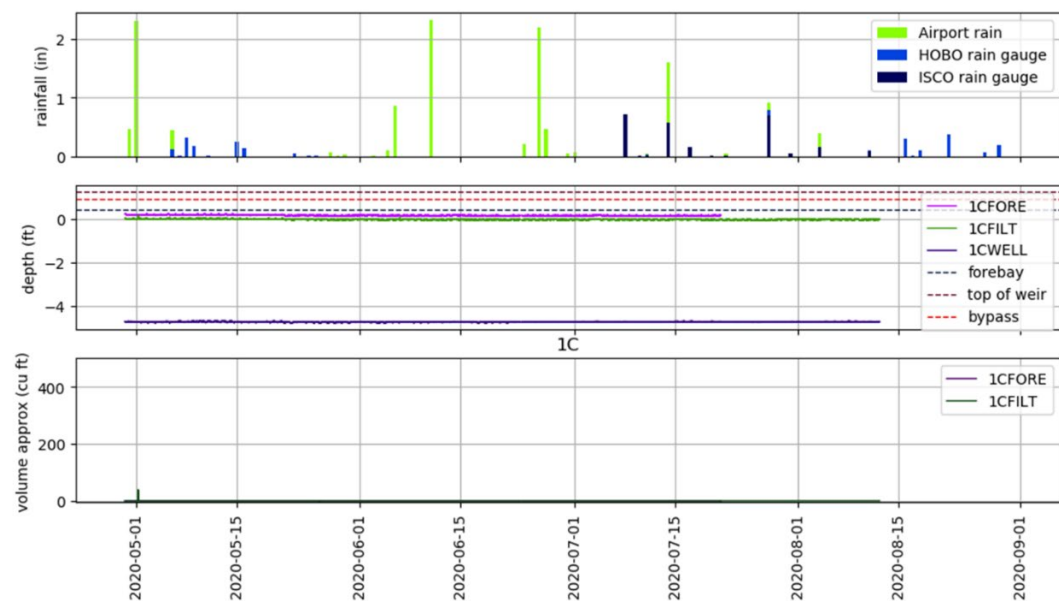Table 2: Estimated volume infiltrated by BMP 1C for each storm monitored.

Figure 2: Water level in BMP 1C over time, with rainfall plotted above, and estimated water volume plotted below.

1E

Photo of BMP 1E from Providence Stormwater Innovation Center

This BMP infiltrated an estimated 20,000 gallons of water over the 6 months monitored.

Event Date	Precipitation (in)	Volume in (ft³)	Volume bypass (ft³)	Infiltration (ft³)	Infiltration (gal)
4/30/2020	0.46	74	0	74	554
4/30/2020	2.32	0	0	0	0
5/1/2020	-	390	0	390	2,920
5/6/2020	0.12	28	0	28	207
5/8/2020	0.51	157	0	157	1,173
5/15/2020	0.11		0	0	0
5/15/2020	0.28	39	0	39	290
6/5/2020	0.14		0	0	0
6/6/2020	0.77	391	0	391	2,922
6/11/2020	2.33	175	0	175	1,308
6/24/2020	0.21		0	0	0
6/26/2020	2.19		0	0	0
6/27/2020	0.47	44	0	44	329
7/8/2020	0.72		0	0	0
7/14/2020	0.576	124	0	124	928
7/17/2020	0.168	21	0	21	161
7/28/2020	0.708		0	0	0
8/4/2020	0.12	23	0	23	172
8/16/2020	0.31		0	0	0
8/18/2020	0.11		0	0	0
8/22/2020	0.38	108	0	108	805
8/29/2020	0.19	15	0	15	112
9/2/2020	0.46	168	0	168	1,260
9/30/2020	0.64	193	0	193	1,443
10/5/2020	0.24	0	0	0	0
10/7/2020	0.11	0	0	0	0
10/13/2020	0.92	138	0	138	1,029
10/16/2020	1.91	393	0	393	2,937
10/20/2020	0.37	232	0	232	1,733
TOTAL				2,711	20,283

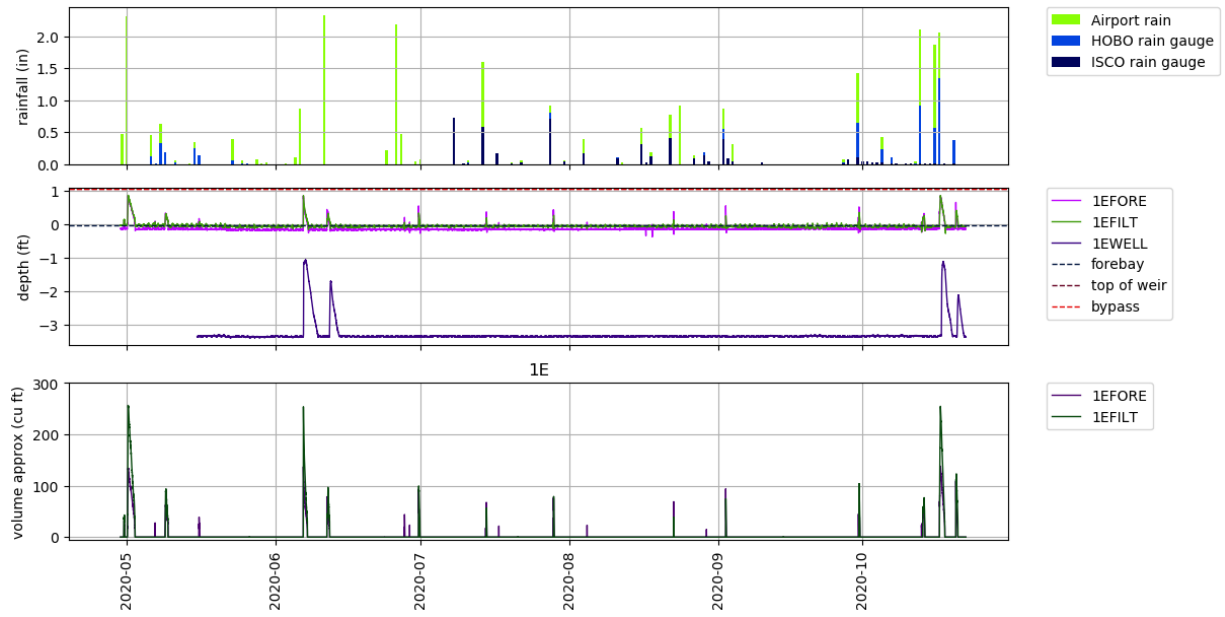Table 3: Estimated volume infiltrated by BMP 1E for each storm monitored.

Figure 3: Water level in BMP 1E over time, with rainfall plotted above, and estimated water volume plotted below.

1B

Photo of BMP 1B from Providence Stormwater Innovation Center

This BMP infiltrated an estimated 965 gallons over the two months monitored. This BMP is between two roads and has a drop inlet for runoff on one road, and just a curb cut for runoff on the second road. When we checked during a heavy rain the curb cut inlet did not appear to be contributing much water.

Event Date	Precipitation (in)	Volume in (ft³)	Volume bypass (ft³)	Infiltration (ft³)	Infiltration (gal)
8/4/2020	0.12	0	0	0	0
8/16/2020	0.31	0	0	0	0
8/18/2020	0.11	0	0	0	0
8/22/2020	0.38	33	0	33	247
8/29/2020	0.19	4	0	4	32
9/2/2020	0.51	38	0	38	283
9/30/2020	0.64	0	0	0	0
10/5/2020	0.24	0	0	0	0
10/7/2020	0.11	0	0	0	0
10/13/2020	0.92	4	0	4	33
		6	0	6	42
10/16/2020	1.91	9	0	9	65
		30	0	30	223
10/20/2020	0.37	5	0	5	40
TOTAL				129	965

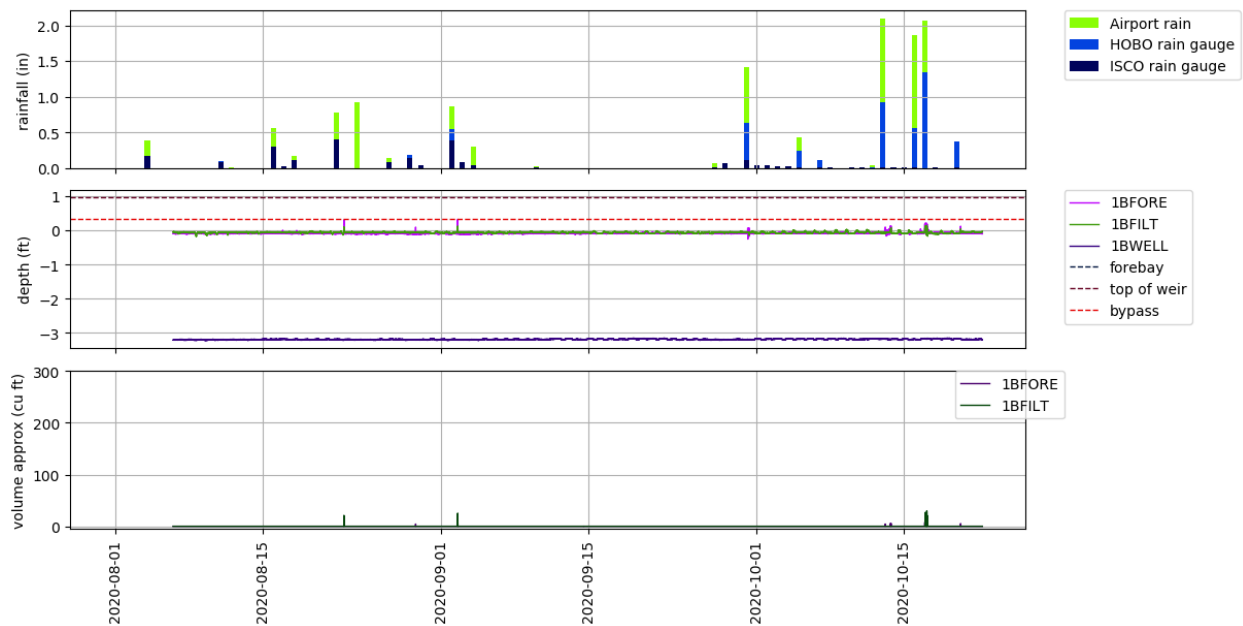Table 4: Estimated volume infiltrated by BMP 1B for each storm monitored.

Figure 4: Water level in BMP 1B over time, with rainfall plotted above, and estimated water volume plotted below.

BMP 37C

Photo of BMP 37C from Providence Stormwater Innovation Center

BMP 37C was only monitored with two dataloggers because of its large shallow design, and an error in the deployment of one logger led to some data loss at the beginning of the monitoring period. This BMP did not appear to have received any significant rainfall during the month and a half both loggers were working, in spite of there being several large storm events. The inlet does not have a very aggressive slope which may contribute to poor performance. This BMP is located near the top of a hill and receives runoff from a fairly narrow road, so it is likely that the watershed is small relative to the capacity of the BMP and does not contribute enough runoff for the logger to measure.

Event Date	Precipitation (in)	Volume in (ft³)	Volume bypass (ft³)	Infiltration (ft³)	Infiltration (gal)
5/26/21	0.252	0	0	0	0
5/28/21	2.388	0	0	0	0
5/30/21	0.588	0	0	0	0
6/4/21	0.624	0	0	0	0
6/12/21	0.144	0	0	0	0
6/14/21	0.78	0	0	0	0
6/24/21	2.33	0	0	0	0
7/1/21	1.62	0	0	0	0
7/3/21	1.03	0	0	0	0
TOTAL				0	0

Table 5: Estimated volume infiltrated by BMP 37C for each storm monitored.
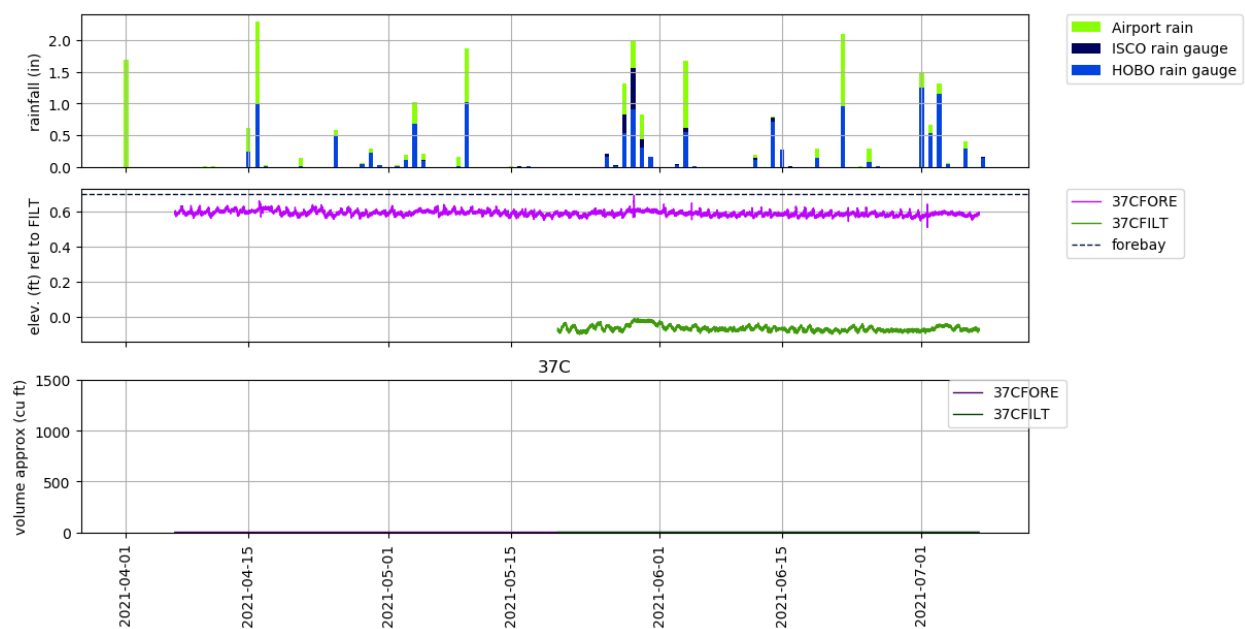

Figure 5: Water level in BMP 37C over time, with rainfall plotted above, and estimated water volume below.

BMP 19C

Photo of BMP 19C from Providence Stormwater Innovation Center

This BMP only infiltrated an estimated 2600 gallons of water over the three months it was monitored. This BMP could potentially treat runoff from a large section of street, but only has a short section of curb cut without any additional grading in the street to encourage water flowing along the curb to enter the inlet.

Event Date	Precipitation (in)	Volume in (ft³)	Volume bypass (ft³)	Infiltration (ft³)	Infiltration (gal)
4/15/21	1.23	30	0	30	226
4/25/21	0.5	0	0	0	0
4/29/21	0.26	0	0	0	0
5/3/21	0.8	0	0	0	0
5/9/21	1.01	0	0	0	0
5/26/21	0.252	0	0	0	0
5/28/21	2.388	0	0	0	0
5/30/21	0.588	21	0	21	158
6/4/21	0.624	0	0	0	0
6/12/21	0.144	0	0	0	0
6/14/21	0.78	0	0	0	0
6/19/21	2.38	0	0	0	0
6/22/21	0	20	0	20	148
6/24/21	2.33	0	0	0	0
7/1/21	1.62	116	0	116	871
7/3/21	1.03	156	0	156	1,164
7/6/21	0.3	0	0	0	0
TOTAL				343	2,568

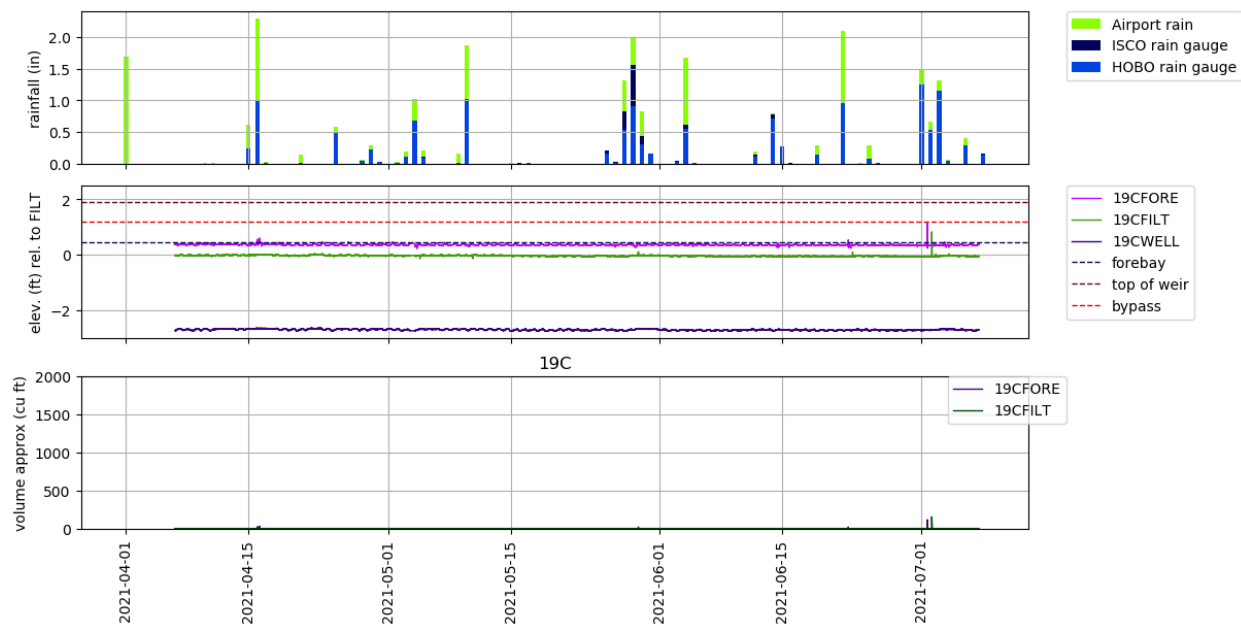Table 6: Estimated volume infiltrated by BMP 19C for each storm monitored.

Figure 6: Water level in BMP 19C over time, with rainfall plotted above, and estimated water volume below.

BMP 15

Photo of BMP 15 from Providence Stormwater Innovation Center

BMP 15 infiltrated an estimated 135,000 gallons of water over the three months it was monitored. We noticed debris collecting in the gabion weir and some soft spots around it when we surveyed, so some attention should be given in the future to make sure the weir does not clog or erode.

Event Date	Precipitation (in)	Volume in (ft³)	Volume bypass (ft³)	Infiltration (ft³)	Infiltration (gal)
4/9/21	0	29	0	29	220
4/15/21	1.23	1,804	0	1,804	13,493
4/23/21	0	34	0	34	251
4/25/21	0.5	938	0	938	7,020
4/28/21	0	232	0	232	1,735
4/29/21	0.26	365	0	365	2,729
5/3/21	0.8	1,592	0	1,592	11,910
5/5/21	0	419	0	419	3,138
5/6/21	0	26	0	26	196
5/9/21	1.01	1,966	0	1,966	14,710
5/26/21	0.252	361	0	361	2,701
5/28/21	2.388	2,477	0	2,477	18,527
5/30/21	0.588	0	0	0	0
6/4/21	0.624	1,111	0	1,111	8,313
6/12/21	0.144	274	0	274	2,046
6/14/21	0.78	1,187	0	1,187	8,876
6/15/21	0	539	0	539	4,030
6/19/21	2.38	338	0	338	2,529
6/22/21	0	1,152	0	1,152	8,619
6/24/21	2.33	311	0	311	2,327
7/1/21	1.62	2,030	0	2,030	15,188
7/3/21	1.03	330	0	330	2,470
7/6/21	0.3	516	0	516	3,857
TOTAL				18,032	134,885

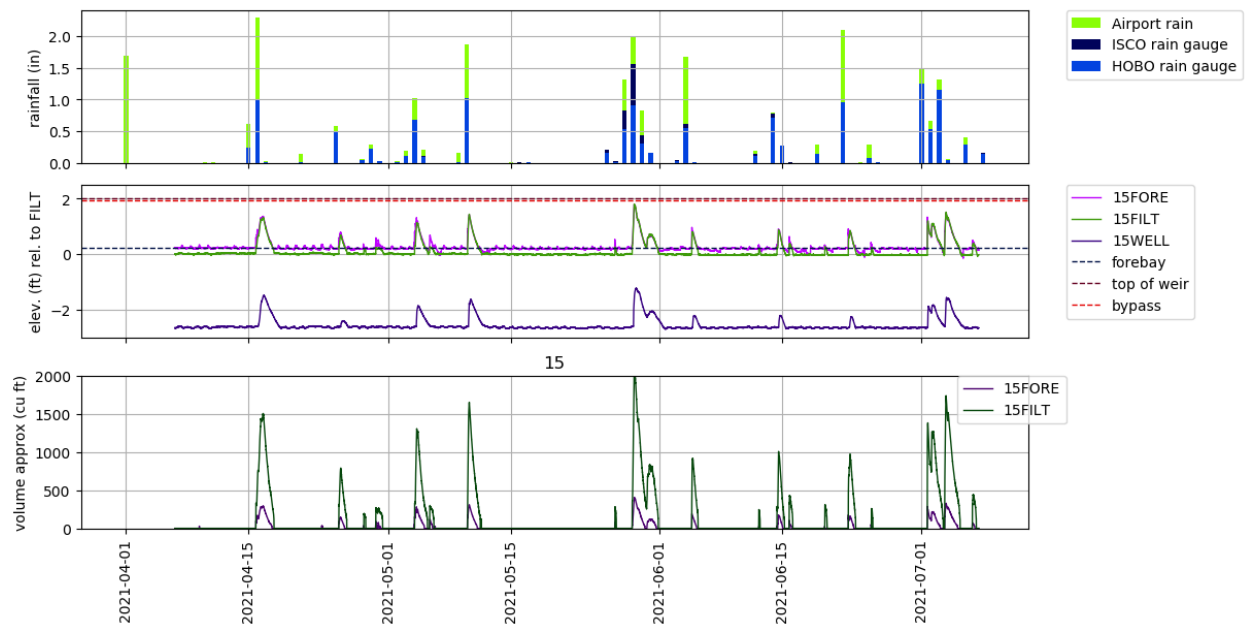Table 7: Estimated volume infiltrated by BMP 15 for each storm monitored.

Figure 7: Water level in BMP 15 over time, with rainfall plotted above, and estimated water volume below.

BMP 30B

Photo of BMP 30B from Providence Stormwater Innovation Center

This BMP infiltrated an estimated 168,000 gallons of water during the three month monitoring period. It does not have a traditional bypass structure we could survey, so we were unable to determine if any stormwater bypassed treatment and infiltration.

Event Date	Precipitation (in)	Volume in (ft³)	Bypass (ft³)	Infiltration (ft³)	Infiltration (gal)
7/17/21	1.35	3,820	NA	3,820	28,577
7/27/21	0.13	0	NA	0	0
8/4/21	1.59	2,525	NA	2,525	18,890
8/19/21	0.38	1,500	NA	1,500	11,223
8/22/21	0.47	1,062	NA	1,062	7,944
8/23/21	0.53	1,979	NA	1,979	14,805
8/29/21	0.4	1,729	NA	1,729	12,931
9/1/21	14.26	6,870	NA	6,870	51,394
9/9/21	0.65	383	NA	383	2,865
9/25/21	0.22	108	NA	108	805
10/3/21	1.62	2,094	NA	2,094	15,665
10/16/21	0.38	427	NA	427	3,194
TOTAL				22,498	168,293

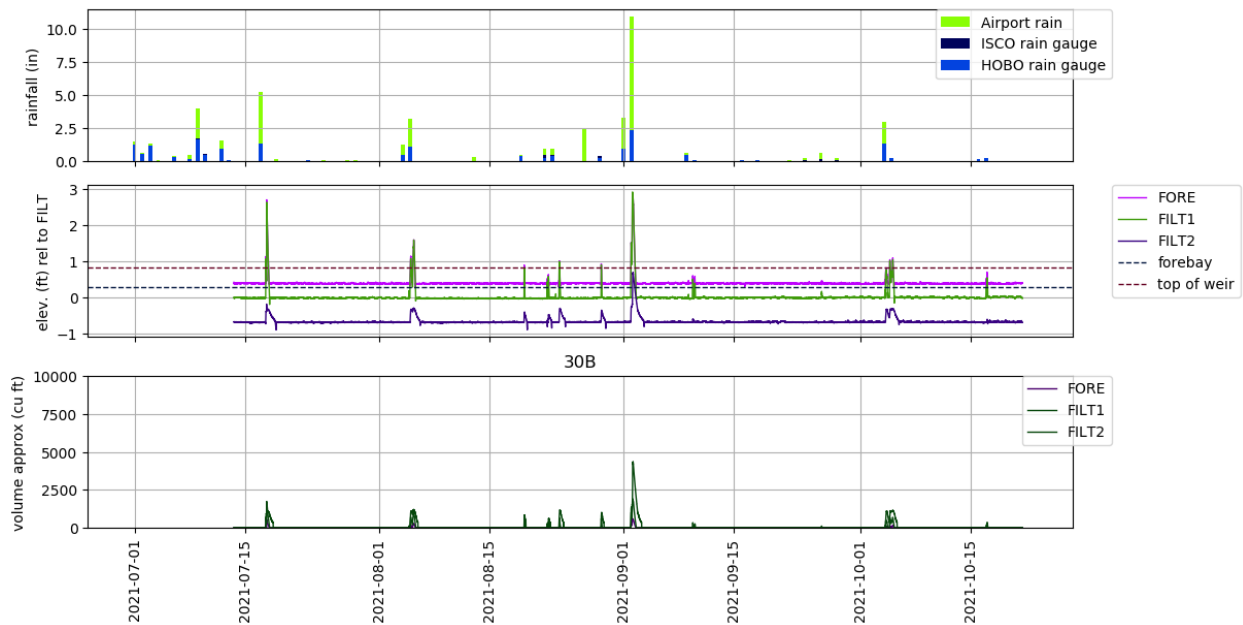Table 8: Estimated volume infiltrated by BMP 30B for each storm monitored.

Figure 8: Water level in BMP 30B over time, with rainfall plotted above, and estimated water volume below.

BMP 28

Photo of BMP 28 from Providence Stormwater Innovation Center

BMP 28 is a large BMP, one of the first BMPs that was built in the park, and infiltrated an estimated 472,000 gallons during the three months it was monitored. It has two forebays that each feed into an infiltration basin between them. One of the forebays received significantly more stormwater than the other. We noted while surveying that the inlets to this BMP have sediment built up in them that may impede water flowing into the BMP. We were unable to obtain anything other than preliminary plans for this BMP so the volume estimates are very approximate.

Event Date	Precipitation (in)	Volume in (ft³)	Volume bypass (ft³)	Infiltration (ft³)	Infiltration (gal)
7/17/21	1.35	12,050	NA	12,050	90,139
7/27/21	0.13	0	NA	0	0
8/4/21	1.59	5,868	NA	5,868	43,895
8/13/21	.	2,615	NA	2,615	19,560
8/19/21	0.38	6,327	NA	6,327	47,327
8/22/21	0.47	2,901	NA	2,901	21,703
8/23/21	0.53	3,940	NA	3,940	29,472
8/29/21	0.4	6,010	NA	6,010	44,955
9/1/21	14.26	15,441	NA	15,441	115,504
9/9/21	0.56	0	NA	0	0
9/25/21	0.22	0	NA	0	0
10/3/21	1.62	4,639	NA	4,639	34,702
10/16/21	0.38	3,272	NA	3,272	24,474
TOTAL				**63,061**	**471,731**

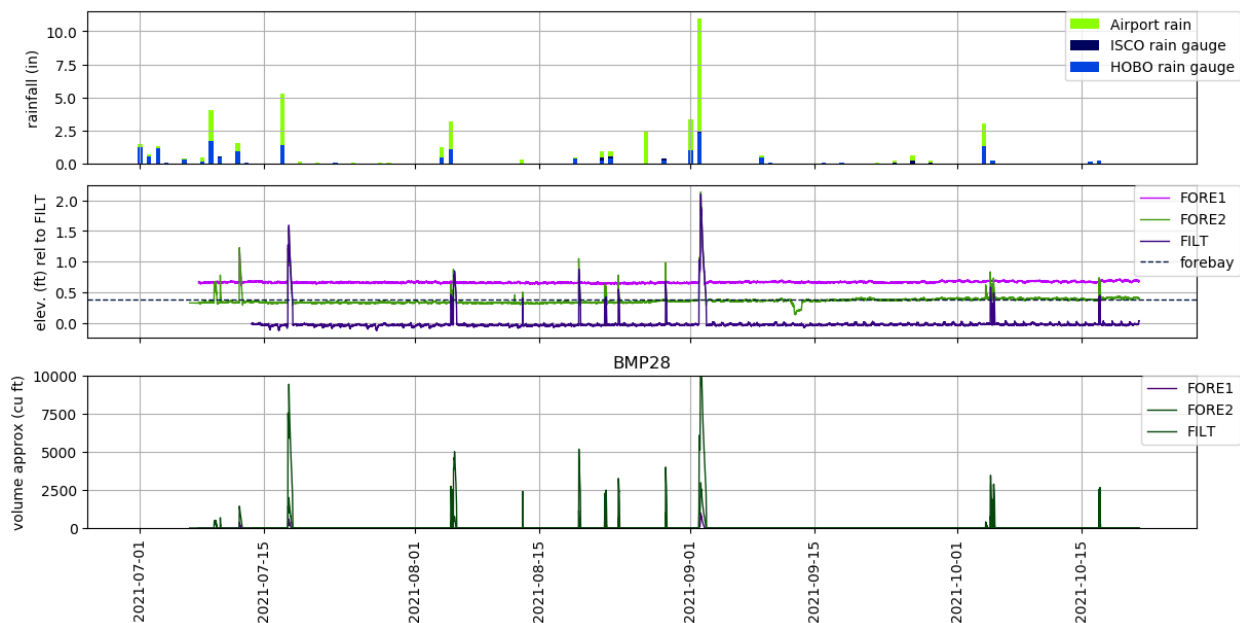Table 9: Estimated volume infiltrated by BMP 28 for each storm monitored.

Figure 9: Water level in BMP 28 over time, with rainfall plotted above, and estimated water volume below.

BMP 34

Photo of BMP 34 from Providence Stormwater Innovation Center

This BMP infiltrated approximately 25,000 gallons of water over the two-month monitoring period. This BMP is large and has multiple basins and features that make determining area of ponding tricky, so this is likely an underestimate. There are two inlets, a small under sidewalk inlet, and a second inlet piped from a catch basin. The sidewalk inlet has the potential to clog easily and should be maintained regularly. There is also some erosion around the weirs.

Event Date	Precipitation (in)	Volume in (ft³)	Volume bypass (ft³)	Infiltration (ft³)	Infiltration (gal)
7/8/21	0.16	216	NA	216	1,618
7/9/21	1.71	319	NA	319	2,384
7/10/21	0.53	76	NA	76	569
7/12/21	0.89	327	NA	327	2,446
7/13/21	0.11	0	NA	0	0
7/17/21	1.35	343	NA	343	2,568
7/23/21	.	43	NA	43	324
7/27/21	0.13	45	NA	45	337
8/4/21	1.59	311	NA	311	2,326
8/19/21	0.38	259	NA	259	1,935
8/22/21	0.47	255	NA	255	1,907
8/23/21	0.53	307	NA	307	2,296
8/29/21	0.4	299	NA	299	2,234
9/1/21	3.31	330	NA	330	2,469
9/9/21	0.56	231	NA	231	1,728
9/18/21	.	30	NA	30	221
9/24/21	0.12	55	NA	55	413
9/25/21	0.22	164	NA	164	1,223
9/28/21	0.26	46	NA	46	343
10/3/21	1.62	313	NA	313	2,342
10/16/21	0.38	236	NA	236	1,762
TOTAL				4,203	31,443

Figure 10: Water level in BMP 34 over time, with rainfall plotted above, and estimated water volume below.
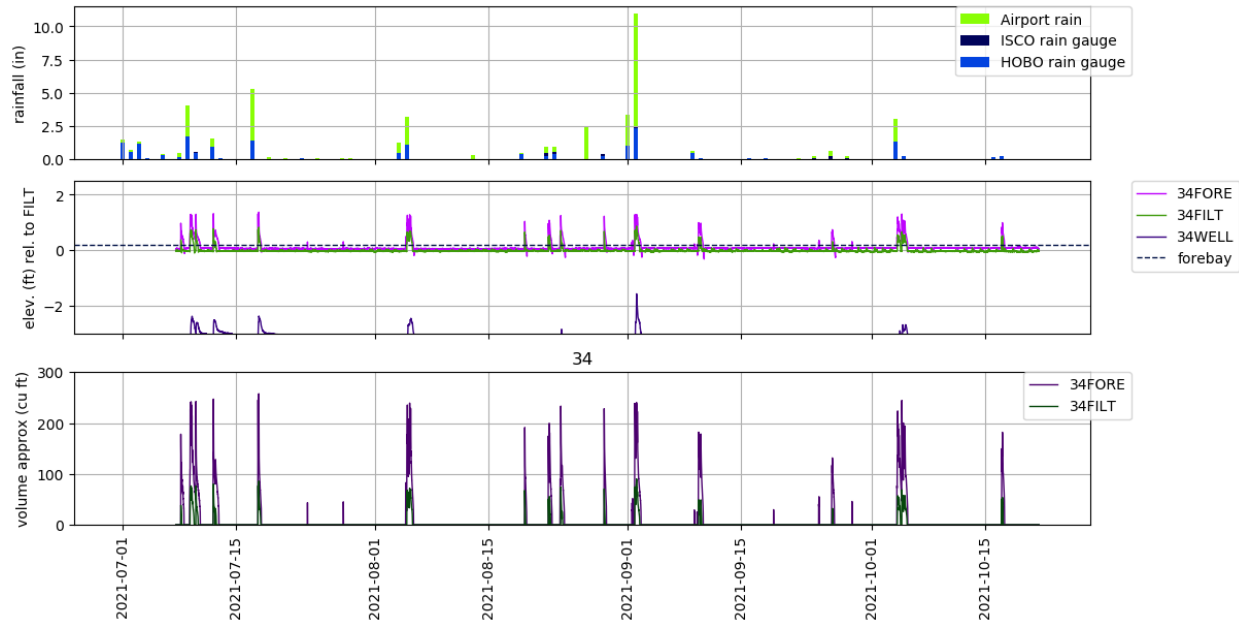
Figure 10: Water level in BMP 34 over time, with rainfall plotted above, and estimated water volume below.

Summary

BMPs 1B, 1C, 1E, 30A, 37C, 19C, 15, 30B, 28, and 34 were monitored for several months each over the course of the summers of 2020 and 2021 using water level loggers. Of the BMPs monitored six (1B, 1E, 30A, 15, 30B, and 34) seemed to be receiving and infiltrating water from storm events of varying sizes. BMP 28 was also getting water but might perform even better if the inlets were cleared of accumulated sediment. BMPs 1C, 37C and 19C were not found to be receiving much if any runoff. Modifying the inlets of 19C and 1C might improve performance. 37C might also be improved with alterations to the inlet but does not seem to be located in a site that gets a lot of runoff.